

What is claimed is:

1. A detector for position of a railway switch, between a normal closed position and a reverse closed position, which switch includes first and second essentially continuous stationary external rails and first and second discontinuous internal rails within a surface area defined by the external rails, said external rails being parallel to each other on one side of the switch and diverging from each other on an opposing side of the switch; the first moveable internal rail being essentially parallel to the first stationary external rail and the second moveable internal rail being essentially parallel to the second stationary external rail, said moveable internal rails crossing each other and being provided with rail gaps at the rail crossing to permit passage of a train wheel flange over one of the internal rails when a train wheel is traveling on the other internal rail, each of the internal rails being provided with a point contact end such that the first internal rail diverts a train wheel to the first internal rail when its point contact is in contact with a corresponding contact point on the second external rail and the second internal rail diverts a train wheel to the second internal rail from the first external rail when its point contact is in contact with a corresponding contact point on the first external rail, said detector comprising at least one sensor including:

i) at least one electromagnetic field generator sensor comprising: a inductance-capacitance (L/C) loop tank circuit that develops an alternating current at a natural resonance frequency to provide an electromagnetic field when the L/C tank circuit is electrically charged; a charging circuit that provides an electrical charge to the tank circuit when amplitude of the frequency drops below a predetermined level; and a feed back from the tank circuit to the charging circuit at the resonance frequency

permitting the charging circuit to determine when the amplitude of the frequency has dropped below the predetermined level; said L/C tank circuit and charging circuit being incapable of maintaining the predetermined amplitude of the frequency when a ferromagnetic material of the mass of the rail of a train switch is close enough to the sensor to be located in a center of the field;

ii) at least one means for positioning the electromagnetic field generator proximate at least a first of the contact points on a rail of said switch so that the electromagnetic field extends through a spatial area through which its corresponding contact point on another rail moves relative to the first contact point during approach or recession of the corresponding contact point to or from the first contact point, so that the field is affected to cause a drop in the frequency amplitude below a second threshold level that is below the predetermined level when corresponding rails are sufficiently close to safely permit passage of a train and so that there is a further drop in frequency amplitude below a third threshold level below the second threshold level when the corresponding rails are sufficiently close so that the affect of the second rail upon the field is maximized.;

iii) at least one means for detecting an increase in frequency amplitude above a first threshold level above the predetermined level indicating that the electromagnetic field generator is no longer in a proper position relative to the first contact point, for detecting the drop in frequency amplitude below the second threshold level to indicate approach and relative positions of corresponding rails, and for detecting the drop in frequency amplitude below the third threshold level to

indicate that the first contact point and its corresponding contact point are separated by less than 0.1 inch; and

iv) a means for compensating for drift of frequency amplitude from the predetermined level when the drift is between the first and third threshold levels and for ceasing such compensating when the frequency amplitude is above the first threshold level or below the second threshold level.

2. The detector of claim 1 wherein one sensor is located proximate at least one of the corresponding contact points on the first internal and second external rails, and another sensor is located on at least one of the corresponding contact points on the second internal and first external rails.

3. The detector of claim 2 wherein one sensor is located proximate the contact point on the first internal rail, and another sensor is located proximate the contact point on the second internal rail, said external rails being stationary relative to the earth but moveable through the fields relative to the internal rails..

4. The detector of claim 2 wherein one sensor is located proximate the contact point on the first external rail, and another sensor is located proximate the contact point on the second external rail.

5. The detector of claim 1 wherein the field generator comprises a directional ferrite pot core coil.

6. The detector of claim 1 further comprising a processing module for comparing predetermined levels and threshold levels of the sensors to determine status of switch position.

7. The detector of claim 6 where the processing module comprises a microprocessor.
8. The detector of claim 1 wherein the charging circuit comprises an electronic switch having a transistor that is activated by means of feed back from the tank circuit to the base of the transistor to permit charging of the tank circuit when amplitude of the frequency drops below the predetermined level.
9. The detector of claim 8 wherein the means for compensating for drift is a means for providing compensation to the transistor to prevent drift by the switch, in providing of charging of the tank circuit, when amplitude of the frequency drops below the predetermined level.
10. The detector of claim 8 wherein the predetermined level is between 70 and 85 percent of the voltage available to drive the charging circuit.
11. The detector of claim 10 where a resistance is provided between the collector and base of the transistor to permit the predetermined level to be below the voltage available to drive the charging circuit.
12. The detector of claim 11 wherein the ratio of the resistance of the resistor to the inductance of the tank circuit is from about 1:20 to about 1:40 ohms to mH to control sensitivity of the detector.
13. The detector of claim 10 wherein the predetermined level is from about 3.5 to about 6 volts.
14. The detector of claim 1 wherein the inductance-capacitance (L/C) loop tank circuit comprises a directional inductor in the form of a pot core comprising a concave ferrite material core wound with an insulated electrically conductive wire that

provides a sufficient inductance to operate in conjunction with the capacitance to form the alternating current at the natural resonance frequency to provide the electromagnetic field when the L/C tank circuit is electrically charged.

15. The detector of claim 1 wherein a microprocessor measures and records the change in amplitude and compares the change with preprogrammed and stored threshold values to determine switch position.

16. The detector of claim 2 wherein a microprocessor measures and records the change in amplitude and compares the change with preprogrammed and stored threshold values to determine switch position.

17. The detector of claim 15 wherein the output of the charging circuit is adjusted by the microprocessor to compensate for temperature changes and for accumulation of metal shavings near the inductance-capacitance (L/C) loop tank circuit and the compensation is halted by the microprocessor when a rail moving relatively toward a sensor, partially affects the field so that the frequency amplitude drops below the second threshold value.

18. The detector of claim 17 wherein the detector contains a memory containing information on temperature affects upon each specific sensor and a means for measuring temperature in an environment around the sensor and the microprocessor adjusts output from a sensor by comparing measured temperature with said information.

19. The detector of claim 2 wherein both electromagnetic field generators operate independently at different natural resonance frequencies so that drops in frequency

amplitude can be measured with respect to each field generator sensor without interference from the other field generator sensor.

20. The detector of claim 16 wherein the microprocessor compares change in amplitude with an internal library of amplitudes representing various positions of a contact point relative to a corresponding rail.

21. The detector of claim 17 wherein the microprocessor compares change in amplitude with an internal library of amplitudes representing various positions of contact points relative to corresponding rails between a completely closed normal switch position and a completely closed reverse switch position

22. The detector of claim 7 wherein the microprocessor measures frequency amplitude upon power up and uses resulting power up information to compensate for position of field generator sensors.

23. The detector of claim 16 wherein the microprocessor measures frequency amplitude upon power up and uses resulting power up information to compensate for position of field generator sensors.

24. The detector of claim 22 wherein frequency amplitude is continuously monitored and compared with power up information and the difference is used to determine dislocation or misalignment of sensors.

25. The detector of claim 23 wherein frequency amplitude is continuously monitored and compared with power up information and the difference is used to determine dislocation or misalignment of sensors.

26. The detector of claim 24 where a fail safe signal output is initiated by the microprocessor when a positive difference determined by subtracting the power up

information from the monitored frequency amplitude exceeds a fail safe threshold level.

27. The detector of claim 25 where a fail safe signal output is initiated by the microprocessor when a positive difference determined by subtracting the power up information from the monitored frequency amplitude exceeds a fail safe threshold level.

28. A method for detecting for position of a railway switch comprising using the detector of claim 1.

29. The method of claim 28 for detecting for position of a railway switch, between a normal closed position and a reverse closed position, which switch includes first and second essentially continuous stationary external rails and first and second discontinuous internal rails within a surface area defined by the external rails, said external rails being parallel to each other on one side of the switch and diverging from each other on an opposing side of the switch; the first moveable internal rail being essentially parallel to the first stationary external rail and the second moveable internal rail being essentially parallel to the second stationary external rail, said moveable internal rails crossing each other and being provided with rail gaps at the rail crossing to permit passage of a train wheel flange over one of the internal rails when a train wheel is traveling on the other internal rail, each of the internal rails being provided with a point contact end such that the first internal rail diverts a train wheel to the first internal rail when its point contact is in contact with a corresponding contact point on the second external rail and the second internal rail diverts a train wheel to the second internal rail from the first external rail when its point contact is in contact with a

corresponding contact point on the first external rail, said method comprising the steps of :

a) generating an electromagnetic field by means of at least one electromagnetic field generator sensor comprising: a inductance-capacitance (L/C) loop tank circuit that develops an alternating current at a natural resonance frequency to provide an electromagnetic field when the L/C tank circuit is electrically charged;

b) providing an electrical charge to the tank circuit when amplitude of the frequency drops below a predetermined level by means of a charging circuit;

c) providing a feed back from the tank circuit to the charging circuit at the resonance frequency permitting the charging circuit to determine when the amplitude of the frequency has dropped below the predetermined level where the L/C tank circuit and charging circuit are incapable of maintaining the predetermined amplitude of the frequency when a ferromagnetic material of the mass of the rail of a train switch is located in a center of the field;

d) positioning the electromagnetic field generator proximate at least a first of the contact points on a rail of said switch so that the electromagnetic field extends through a spatial area through which its corresponding contact point on another rail moves relative to the first contact point during approach or recession of the corresponding contact point to or from the first contact point, so that the field is affected to cause a drop in the frequency amplitude below a second threshold level that is below the predetermined level when corresponding rails are sufficiently close to safely permit passage of a train and so that there is a further drop in frequency amplitude below a third threshold level below the second threshold level when the



corresponding rails are sufficiently close so that the affect of the second rail upon the field is maximized.;

e) detecting when there is an increase in frequency amplitude above a first threshold level above the predetermined level indicating that the electromagnetic field generator is no longer in a proper position relative to the first contact point;

f) detecting the drop in frequency amplitude below the second threshold level to indicate approach and relative positions of corresponding rails;

g) detecting the drop in frequency amplitude below the third threshold level to indicate that the first contact point and its corresponding contact point are separated by less than 0.1 inch; and

h) compensating for drift of frequency amplitude from the predetermined level when the drift is between the first and second threshold levels and ceasing such compensating when the frequency amplitude is above the first threshold level or below the second threshold level.

30. The method of claim 29 further comprising locating one sensor proximate at least one of the corresponding contact points on the first internal and second external rails, and locating another sensor on at least one of the corresponding contact points on the second internal and first external rails.

31. The method of claim 30 comprising locating one sensor proximate the contact point on the first internal rail, and locating another sensor proximate the contact point on the second internal rail, said external rails being stationary relative to the earth but moveable through the fields relative to the internal rails..

32. The method of claim 30 further comprising locating one sensor proximate the contact point on the first external rail, and locating another sensor proximate the contact point on the second external rail.
33. The method of claim 29 comprising using a field generator comprising a directional ferrite pot core coil.
34. The method of claim 29 further comprising using a processing module for comparing predetermined levels and threshold levels of the sensors to determine status of switch position.
35. The method of claim 34 further comprising using a processing module comprises a microprocessor.
36. The method of claim 29 wherein a switch in the charging circuit comprises a transistor that is activated by means of feed back from the tank circuit to the base of the transistor to permit charging of the tank circuit when amplitude of the frequency drops below the predetermined level.
37. The method of claim 30 wherein a switch in the charging circuit comprises a transistor that is activated by means of feed back from the tank circuit to the base of the transistor to permit charging of the tank circuit when amplitude of the frequency drops below the predetermined level.
38. The method of claim 36 wherein the predetermined level is between 70 and 85 percent of voltage available to drive the charging circuit.
39. The method of claim 36 comprising providing a resistance between the collector and base of the transistor to permit the predetermined level to be below the voltage available to drive the charging circuit.

40. The method of claim 39 wherein the ratio of the resistance to the inductance of the tank circuit is from about 1:20 to about 1:40 ohms to mH to control sensitivity of the detector.

41. The method of claim 38 wherein the predetermined level is from about 3.5 to about 6 volts.

42. The method of claim 29 comprising using an inductance-capacitance (L/C) loop tank circuit that comprises a directional inductor in the form of a pot core comprising a concave ferrite material core surrounded by an insulated radially wound electrically conductive wire that provides a sufficient inductance to operate in conjunction with the capacitance to form the alternating current at the natural resonance frequency to provide the electromagnetic field when the L/C tank circuit is electrically charged.

43. The method of claim 30 comprising using an inductance-capacitance (L/C) loop tank circuit that comprises a directional inductor in the form of a pot core comprising a concave ferrite material core surrounded by an insulated radially wound electrically conductive wire that provides a sufficient inductance to operate in conjunction with the capacitance to form the alternating current at the natural resonance frequency to provide the electromagnetic field when the L/C tank circuit is electrically charged.

44. The method of claim 29 wherein a microprocessor is used to measure and record the change in amplitude and compares the change with preprogrammed and stored threshold values to determine switch position.

45. The method of claim 30 wherein a microprocessor is used to measure and record the change in amplitude and compares the change with preprogrammed and stored threshold values to determine switch position.

46. The method of claim 44 wherein the output of the charging circuit is adjusted by the microprocessor to compensate for affects of temperature changes upon the inductance-capacitance (L/C) loop tank circuit and the compensation is halted by the microprocessor when a rail moving relatively toward a sensor, partially affects the field so that the frequency amplitude drops below the second threshold value.

47. The method of claim 46 wherein the detector contains a memory containing information on temperature affects upon each specific sensor and a means for measuring temperature in an environment around the sensor and the microprocessor adjusts output from a sensor by comparing measured temperature with said information.

48. The method of claim 44 wherein the output of the charging circuit is adjusted by the microprocessor to compensate for accumulation of metal shavings near the inductance-capacitance (L/C) loop tank circuit and the compensation is halted by the microprocessor when a rail moving relatively toward a sensor, partially affects the field so that the frequency amplitude drops below the second threshold value.

49. The method of claim 30 wherein both electromagnetic field generators operate independently at different natural resonance frequencies.

50. The method of claim 44 wherein the microprocessor compares change in amplitude with an internal library of amplitudes representing various positions of a contact point relative to a corresponding rail.

51. The method of claim 45 wherein the microprocessor compares change in amplitude with an internal library of amplitudes representing various positions of contact points relative to corresponding rails between a completely closed normal switch position and a completely closed reverse switch position

52. The method of claim 44 wherein the microprocessor measures frequency amplitude upon power up and uses resulting power up information to compensate for position of field generator sensors.

53. The method of claim 45 wherein the microprocessor measures frequency amplitude upon power up and uses resulting power up information to compensate for position of field generator sensors.

54. The method of claim 29 wherein frequency amplitude is continuously monitored and compared with power up information and the difference is used to determine dislocation or misalignment of sensors.

55. The method of claim 30 wherein frequency amplitude is continuously monitored and compared with power up information and the difference is used to determine dislocation or misalignment of sensors.

56. The method of claim 54 where a fail safe signal output is initiated by the microprocessor when a positive difference determined by subtracting the power up information from the monitored frequency amplitude exceeds a fail safe threshold level.

57. The method of claim 55 where a fail safe signal output is initiated by the microprocessor when a positive difference determined by subtracting the power up

information from the monitored frequency amplitude exceeds a fail safe threshold level.

58. The method of claim 29 wherein four states of frequency amplitude corresponding to initial positive detection of the rail and at multiple different gap distances of a contact point from its corresponding rail are measured during movement of a contact point within the range of a field generator sensor.

59. The method of claim 58 wherein the multiple different gap distances are 0.1, 0.2, 0.3, 0.4 and 0.5 inch.

60. The method of claim 29 wherein the detector comprises a microprocessor and memory that can be programmed to contain threshold values determined by actual measurement of frequency amplitude at various positions of a contact point of a rail relative to location of a sensor.